

The University of Chicago

---

# A STUDY OF CERTAIN FEATURES OF PUNISHMENT IN SERIAL LEARNING

A DISSERTATION SUBMITTED TO THE  
GRADUATE FACULTY IN CANDIDACY FOR  
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

By  
WILSON McTEER

Private Edition, Distributed by  
THE UNIVERSITY OF CHICAGO LIBRARIES  
CHICAGO, ILLINOIS

---

Reprinted from  
JOURNAL OF EXPERIMENTAL PSYCHOLOGY  
Vol. XIV, No. 4, August, 1931  
and  
Vol. XIV, No. 5, October, 1931





The University of Chicago

---

A STUDY OF CERTAIN FEATURES OF  
PUNISHMENT IN SERIAL LEARNING

A DISSERTATION SUBMITTED TO THE  
GRADUATE FACULTY IN CANDIDACY FOR  
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

By  
WILSON McTEER

Private Edition, Distributed by  
THE UNIVERSITY OF CHICAGO LIBRARIES  
CHICAGO, ILLINOIS

---

Reprinted from  
JOURNAL OF EXPERIMENTAL PSYCHOLOGY  
Vol. XIV, No. 4, August, 1931  
and  
Vol. XIV, No. 5, October, 1931



## A NEW DEVICE FOR SERIAL ORDER LEARNING

BY WILSON McTEER

*College of the City of Detroit*

The apparatus here described serves the following general functions: (a) It presents a finger-response ten-unit multiple-choice serial-order learning problem of sufficient complexity to challenge the abilities of college and graduate students. (b) It is an apparatus in which the problem presented may be varied from day to day in as many ways as the permutation of ten things taken ten at a time. (c) It is an apparatus in which the symbolic aids to learning may be varied in innumerable ways. (d) It presents an apparatus in which both the signal of success and of error is automatic (*i.e.* independent of the experimenter). (e) It is an apparatus in which the signal of correct response may be varied in many ways (*i.e.* varied sense organ, or, varied in spatial location with respect to the same sense organ). (f) The same is also true of the signal of incorrect response or error.

In the present experiment the successful response was indicated by a loud sound emanating from a box in front of the subject. The signal of incorrect response was varied with the experimental group: (a) With the Control group there was merely no response, or no sound. (b) With the Ankle group there was a sharp shock emanating from the smaller of two contacts on the right leg. (c) With the Finger group there was an electric shock emanating from the key touched.

The electric circuits involved in the apparatus are shown in Diagram I. Their function may be outlined best in relation to the procedure of the present experiment:

The subject was seated in an ordinary chair at *A* before a table on which rested the keyboard *B*. The copper wristlet *C* (6.5"  $\times$  1" piece of .005" 'hard brush copper') was fastened on the right wrist by means of a two-inch rubber band

doubled once and slipped over the small hooks soldered to the wristlet. The 'calflet' *D* (same size as above) was similarly attached to the calf of the bare leg with a three-inch rubber band. The 'anklet' *F* was attached in the same manner with a five-inch band on the flat surface of the right ankle midway between the tendon of the tibialis anticus

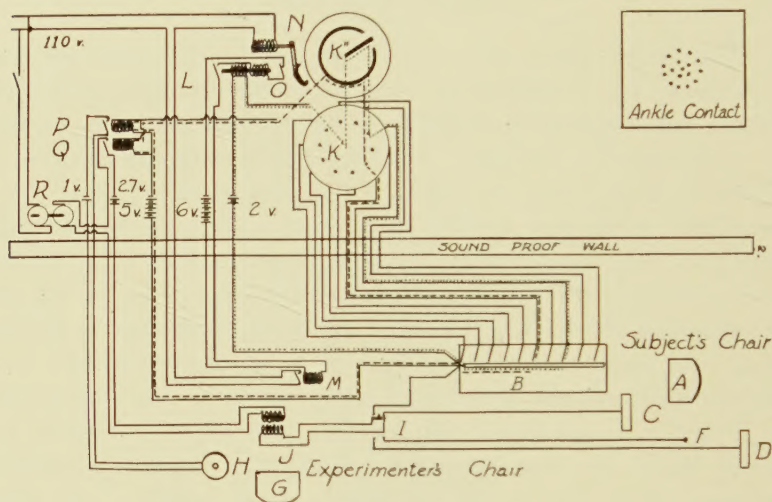


DIAGRAM I

and the tendon of the peroneus longus, about six to eight inches from the floor. This 'anklet' consisted of 17 blunt steel points soldered in a circular piece of  $\frac{1}{32}$ " brass,  $\frac{1}{2}$ " in diameter. The pattern of these points is shown in the inset in the right hand corner of Diagram I.

The experimenter seated himself at *G* with the head-phone *H* over his ear. He set the double-throw-knife-switch *I* so that the subject would receive the shock in the manner appropriate to the group that he was in. The experimenter then adjusted the induction coil *J* to the intensity appropriate to the locus of the shock. The intensities used had been determined by running a preliminary series of experiments. A shock of greater objective intensity was given to the Ankle group, but the subjective experience of the intensity was on the average almost equivalent to that of the Finger group.

After the subject had read the instructions he next di-



rected his attention to the keys on the keyboard *B*. The keyboard consisted of a  $12'' \times 7''$  panel of  $\frac{1}{4}''$  bakelite. On the left of the keyboard was fastened a brass strip ( $\frac{1}{8}'' \times \frac{5}{8}'' \times 12''$ ) milled on the inner side so that a sheet of paper might be slipped between it and a similar brass strip which was in the middle of the panel. The second strip, with a binding post attached on the end away from the subject, served as a common contact for all the keys. The keys were made of  $\frac{1}{32}''$  copper ( $\frac{3}{8}'' \times 3\frac{1}{2}''$ ) and were bent up from the board so that they were normally  $\frac{3}{32}''$  above the central brass strip. They were anchored to the bakelite by a screw and an inset binding post; the screw was set  $2\frac{1}{4}''$  away from the free end.

If the subject was lucky and struck the 'correct key,' the 2 v. circuit indicated by the dotted line was completed through the rotary switch *K* and the 'self-holding' telephone relay was pulled shut. The 'holding' circuit which ran through the telephone relay was the 6 v. circuit that actuated the sound hammer *M*. As the sound hammer hit its base it served the double function of, first, telling the subject that the response was correct, and, second, of closing the 110 v. circuit through the solenoid *N*. The pull of the solenoid also accomplished two results: (a) it pulled the escapement-arm holding the escapement-wheel of the rotary switch and allowed the switch to rotate half a step; (b) as the escapement-arm completed its swing it opened the spring switch at *O*. Opening the switch at *O* broke the 6 v. circuit of the self-holding relay, this allowed the sound hammer to swing open and thus broke the 110 v. circuit. As the pull on the solenoid was released, a spring on the escapement-arm drew it back to its first position. This movement of the escapement-arm permitted the rotary switch to move the remaining half step forward, which 'set' it for the next correct response.

But, if the subject was not so fortunate, he struck one of the other nine keys and completed the 5 v. circuit shown by the line of dashes. This circuit actuated the telegraph relays *P* and *Q*. The relay *P* completed the 1.5 v. circuit

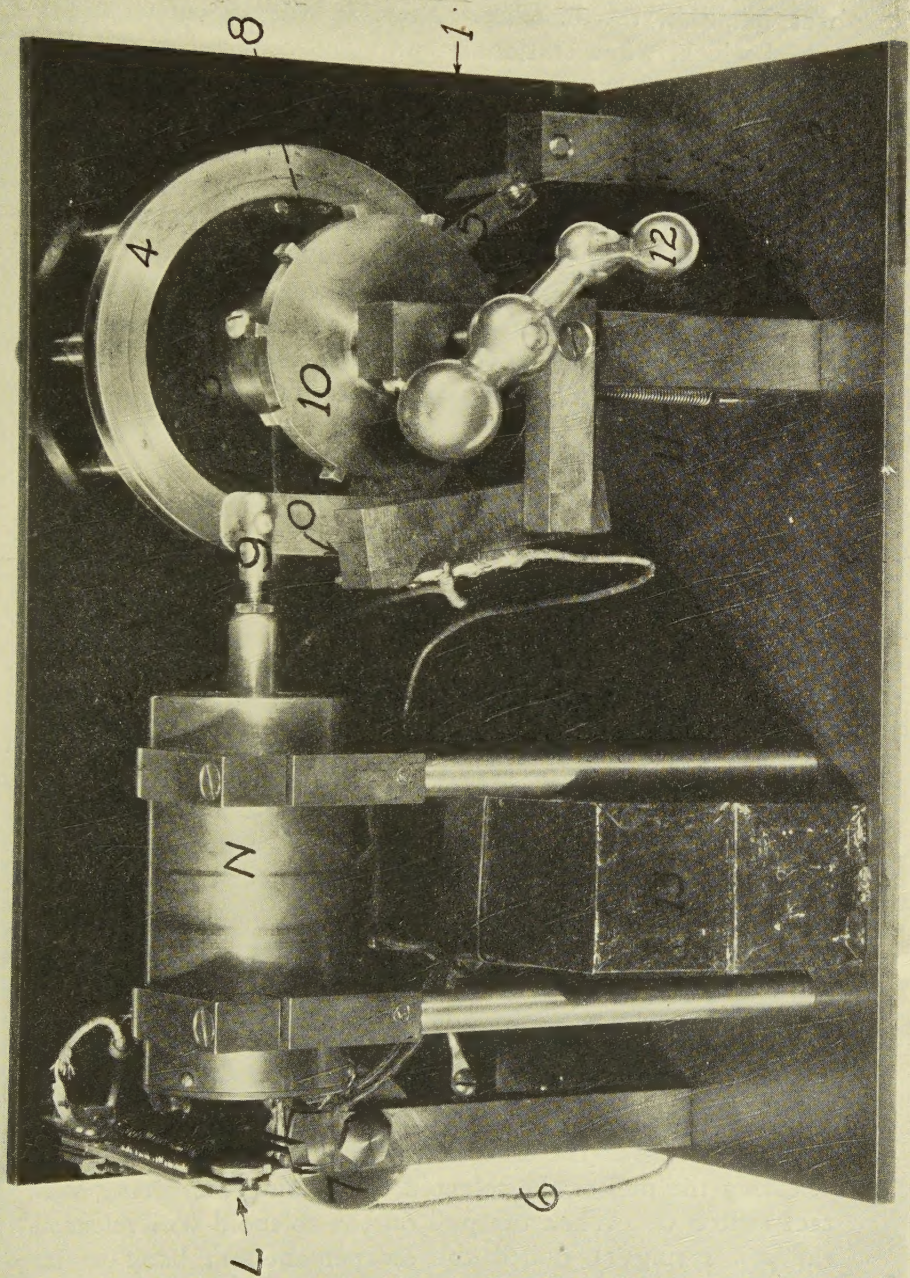
through the headphone *H* (a recording pen could easily be substituted for the headphone used in this experiment). The click of the headphone indicated to the experimenter that the subject had made an error. The relay *Q* completed the 2.7 v. (two cells of an Edison nickle plate sodium hydroxide storage battery) circuit through the motor driven interrupter *R* (which interrupted the current 720 times per second) and the primary circuit of the induction coil *J*. The induced current from the secondary circuit of the induction coil *J* passed to the double-throw-knife-switch *I*, and there its course varied with the experimental group to which the subject was allocated. If the subject was a member of the 'control' group, the switch *I* was left open. If the subject was a member of the 'finger' group, the switch was pushed 'up' and the circuit was completed through the central brass strip of the keyboard, through the key that was being held down, and through the subject's finger and hand to the wristlet *C*. If the subject was a member of the 'ankle' group, the switch *I* was pushed 'down' and the circuit was completed through the small contact *F*, and through the subject's leg to the 'calfllet' *D*.

The principle and operation of the rotary switch shown in Plate I may be summarized in the following manner:

Ten metal points of equal height were equally spaced around the circumference of a circle on the ( $12'' \times 6\frac{3}{4}'' \times \frac{1}{4}''$ ) bakelite panel 1 which was anchored to the ( $12'' \times 6'' \times \frac{1}{4}''$ ) brass base 2. A flat washer-like ring of metal ( $\frac{1}{2}''$  width) of larger outer and smaller inner diameter was fastened to the inner surface of the circular bakelite plate 3 of  $4\frac{1}{2}''$  diameter whose axis of rotation was the center of the circle of metal points. At this stage we had a composite wheel which provided a continuous metallic contact with all ten points, regardless of whether the wheel was stationary or rotated.

A segment of a little less than two-tenths of the circumference was next removed from the metal ring and a bakelite inlay was substituted. A metal strip ( $\frac{3}{8}''$  width) running from the center of the wheel to the circumference midway





between the two ends of the remaining segment of the ring was inlaid in the bakelite. Now, at this stage we had a wheel which, when stationary, provided continuous metallic contact around the circumference for nine of the keys while the tenth key was in contact with the center; when rotated, each metallic point was successively in contact with the center while the other nine were in contact with the remaining segment of the ring. This permitted one key to be the 'correct key' while the other nine were 'errors.'

The addition of another washer-like ring 4 ( $\frac{1}{2}$ " width) to the outside of the bakelite wheel, but in continuous metallic contact with the inner 'eight-tenths' segment, and a 'rider' 5 to provide continuous stationary contact with the outer ring completed this part of the circuit which indirectly provided punishment for errors.

If we next added to this wheel some mechanism which would provide a rotation of one-tenth the circumference each time an electric circuit was completed through the strip which was in contact with the center and the circumference we would have essentially the rotary switch of the present experiment.

The mechanism which provided the rotation of the bakelite wheel is not clearly shown in the picture or diagram. The principle, however, was the same as that used in most watches and spring or gravity driven clocks in which the advancement of the mechanism is controlled by an escapement device. A constant rotational pull was provided by the four and one-half pound weight attached to the string 6 which ran over the pulley 7 to the spindle 8 ( $\frac{3}{4}$ " diameter). Rotation resulted when the 110 v. solenoid *N* ( $5\frac{3}{4}$ " above the base at the center) pulled the escapement-arm 9 and permitted the escapement wheel 10 to turn one-twentieth of a turn until caught by the lower pallet of the escapement arm. The escapement wheel used was  $2\frac{3}{4}$ " diameter inside the cogs; the cogs were  $\frac{5}{32}$ " in height. As previously pointed out, this swing of the escapement-arm resulted indirectly in releasing the pull of the solenoid by opening the spring contact switch *O*. When the pull on the solenoid was released the coil spring 11 pulled the escapement-arm back to its



original position and again permitted the escapement wheel to turn one-twentieth of a turn, and thus set it ready for a new advance.

The crank 12 was used in rewinding the string after a series of trials. In the present experiment twenty-three trials could be run before rewinding was necessary. The two condensers 13 were used to cut down the spark resulting from the closing of the 110 v. solenoid circuit. The self-holding relay *L* has previously been described.

On the rear of the bakelite panel were terminals to which the wires from the keys could be attached. Since these wires were of equal length the combination or series to be learned could be easily changed.

(Manuscript received September 2, 1930)





## A STUDY OF CERTAIN FEATURES OF PUNISHMENT IN SERIAL LEARNING

BY WILSON McTEER<sup>1</sup>

*College of the City of Detroit*

### CHAPTER I. INTRODUCTION

Watson (8) has advanced the theory that 'conditioning' to the 'social don'ts' would be accomplished best by punishment direct from the perceptual situation. There are at least six independent variables to be considered in making an experimental test of this theory: (a) The subject, who may vary in sex, age, experience, intelligence, etc; (b) The activity pattern desired, whether acquisitive or eliminative, slow or fast, etc; (c) The punishment used, whether intense or mild, whether automatic or administered by some person, etc; (d) The spatial relation of the punishment to the reacting member; (e) The temporal relation of the punishment to the act; (f) The subject's perceptual understanding of the relation of the punishment to the act.

Since the learning problem used in this experiment is a new one, the principal question investigated in this research is to determine whether electric shock punishment in a ten-unit finger-response multiple-choice serial-order learning problem would result in more or less efficient learning than when no punishment is used.

Secondarily, the present experiment is concerned with the

<sup>1</sup> From the Psychological Laboratory of the University of Chicago. The writer wishes to express his appreciation to Professor A. G. Bills for suggesting the problem and for his valuable counsel during the course of the experimentation.

fourth variable mentioned above. The attempt is made to determine whether punishment applied to the ankle in this type of learning would result in more or less efficient learning than punishment applied to the reacting finger.

Several investigators have dealt with the more general problem of electric shock punishment in various types of situations. Johanson (3) found a saving of 15 percent in reaction time when automatic punishment for long reactions was introduced. Warner Brown and collaborators (1) standardized Hamilton's 'multiple choice problem for human subjects' as outlined by Yerkes (10) and added electric shock for error. They report (9) that with the electric shock the problem becomes quite a sensitive measuring instrument, but do not give data comparing punished and non-punished groups.

Rexroad (4, 5) used punishment in a problem in which the five fingers of one hand were each to be associated with a different color and the correct finger was to press a key each time the appropriate color was flashed on a screen. An automatic record was taken of the correct responses and errors that occurred within a constant period of time. Three problems were studied. (a) In a study of the initial adjustment to the situation the punished group made on the average 2 percent more correct responses and 16 percent fewer errors than the control group. (b) A study of a small practiced group using the same combination at each sitting showed a decrease of 2 percent in correct responses and of 15 percent in errors for the days when punishment was used as compared with the days when no punishment was used. (c) A study of another small practiced group which learned a new color-finger-response combination at each sitting showed a decrease of 11 percent in correct responses and of 4 percent in errors for the punishment days as compared with the non-punishment days. In general, one may say that the effect of the punishment in all conditions was to make the subjects more cautious and slower in reacting.

Vaughn (6) investigated the effect of different types of instruction upon quickness of stopping an arm movement in



response to a 'danger signal' or red light. Electric shock punishment for slowness in stopping was the most effective form of 'instruction'. Next in order came (a) threat of punishment with occasional shock; (b) threat of punishment with a demonstration of how it might occur; (c) indefinite threat that something might happen; (d) simple 'don't' instruction; (e) positive instructions were least effective of all the forms used. He, however, called particular attention to the great variation between individuals and their reaction to various forms of instruction.

Bunch (2) introduced punishment for errors into maze learning. Punishment occurred only if the subject went to the end of the blind alley. He found that the punished group learned with fewer errors, fewer trials and less time. He also found that the most effective learning occurred with those subjects who reported that the experience of the shock was only moderately intense.

Vaughn and Diserens (7) have made a special study upon the effect of varying the intensity of the punishment in learning a simple maze. Their maze was constructed so that punishment was received in all parts of the blind alleys. Four patterns were learned under the following conditions of punishment: none, slight, moderate, intense. Each subject served in each condition, and a counterbalancing technique was used so that practice and maze differences supposedly 'washed out' in the final averages. They found fewest trials, fewest errors, and least time with *slight* punishment. Their apparatus was so constructed that they could determine the reaction time of the subject's response to the blind alley, and they report the quickest reaction time with the most intense punishment. They call particular attention to the marked individual differences in reaction to punishment.

Two unpublished studies were carried out at Wisconsin under Hull in '26, '27, and '28 which bordered upon the field of the secondary problem of the present investigation. The problem studied was the effect of punishment as applied to the reacting hand in maze learning compared with punishment applied to the non-reacting hand. The first investigator

claimed to find significant differences in favor of punishing the reacting hand. The second investigator repeated the experiment under more carefully controlled conditions and found practically no differences between the groups she used.

In general, it has been found that punishment of moderate intensity results in more efficient responding in reaction time, in maze learning, and in finger-response-multiple-choice of the types used by both Yerkes and Rexroad. Punishment of severe intensity is reported as being disruptive. The studies of the spatial relation of the punishment to the reacting member report conflicting results and consequently the question remains unsettled.

## CHAPTER II. PROCEDURE AND SUBJECTS

The present experiment was originally outlined with the view of attempting to determine the effect of punishment in the serial order learning of non-sense syllables. Actual experimentation with the apparatus which was designed for this purpose, however, resulted in the substitution of number combinations in preference to non-sense syllables.

The loci of punishment were selected with the view, first, of choosing spots of distinct anatomical and experiential separation; secondly, of selecting areas such that the electrodes could be quickly and conveniently attached without undue embarrassment to naive subjects. The finger and the ankle were the regions best suited to these requirements.

Extended experimentation of more than a year's duration was involved in perfecting the mechanical apparatus, in selecting the electrodes (particularly the ankle contact), in attempting to provide a reasonably constant induction shock punishment; in devising a scale for identifying as nearly as possible the subject's experience of the punishment; in selecting an objectively constant variation in the current that would result in practical equality of the subjective reports of the intensity of the experience; and, in simplifying the learning procedure involved so that all the subjects would follow approximately the same plan in learning, with the exception of those differences resulting from the punishment and from individual eccentricities.

The procedure as finally adopted was as follows: The subject upon entering the room was handed a sheet of type-written instructions (see Appendix A) which, (a) emphasized learning with few repetitions; (b) pointed out that a sound from the box before him was the signal of the choice of the correct key; (c) suggested that a grouping of the key numbers as found would result in quickest learning; (d) warned him that there might be electric shock punishment for errors; (e) asked him to pause upon completing a trial until the experimenter signalled him to continue; (f) told him that the criterion of complete learning was two errorless trials; and (g) requested him not to discuss the experiment with others.

After the subject had read these instructions he was permitted to ask questions concerning any of the details that were not clear. He was then seated at the end of the table and the electrodes were fastened on his right ankle, calf, and wrist regardless of the experimental group to which he belonged.<sup>2</sup>

The experimenter then seated himself at the side of the table, adjusted the induction coil and the punishment circuit to the settings appropriate to the experimental group to which the subject belonged; placed the headphone 'error indicator' over his left ear, set the stopwatches and signalled the subject to start.

The problem the subject faced may best be thought of in terms of a typewriter. Assume a typewriter with only ten keys. Assume further that the typewriter is so built that the carriage will only advance when the right letter of the right word is struck. Suppose the word that this ten-letter machine is set for is 'republican'. Then, the subject's problem is to find the word by the simple process of pounding the keys. Suppose the keys are labeled in the order 'a, b, c, e, i, l, n, p, r, and u'. The subject in starting the first trial, then, might hit the keys a, c, l, r, and at r the carriage would move, indicating that it was the first letter of the word; u, p, n, l, i, e, might come next, and the subject would remember r, e; the, possibly, i, l, n, p; and so through the list until the subject had

<sup>2</sup> See details in W. McTeer, A New Device for Serial Order Learning, *this Journal*, 1931, 14, 446-452.



found the complete correct order *r, e, p, u, b, l, i, c, a, n*. The letters struck out of order would count as errors. In the later repetitions or trials the subject would attempt to spell the word correctly each time, but would repeat it until he had done so twice in succession.

The problem the subject faced in this experiment differed from the above hypothetical machine in that (*a*) a ten-unit number was learned instead of a word, (*b*) the 'advancement' was indicated by the tap of a sound hammer rather than by the movement of a typewriter carriage, (*c*) the keyboard was perpendicular to, rather than parallel with, the plane of the subject's body, and (*d*) in two of the three groups the subject received punishment for errors.

The following combinations were selected and used as presenting problems of approximately equal difficulty: first day: 3 8 2, 10 5 4, 9 7 1 6; second day: 1 9 4, 5 7 10, 2 6 8 3; third day: 8 4 9, 1 3 7, 6 10 2 5.

The experimenter, in addition to keeping the records, watched the subject's hand to prevent an adjustment which seemed to occur regularly in the Finger group. These subjects had the tendency to bend the finger so that they were striking the keys with the finger-nail rather than with the fleshy lobe of the finger. This adjustment tended to reduce the intensity of the punishment and so the subjects would increase their speed of tapping the keys. When this happened the experimenter would warn the subject at the end of the trial that the use of the finger-nail was not permitted.

The following records were kept during the course of the learning: (*a*) time and errors per 'correct' key in the first trial; (*b*) errors per 'correct' key and total time per trial in the later trials; (*c*) relevant comments and unusual events were noted when the speed of the subject permitted. These records were taken each day on a special mimeographed form which also included the subject's name, school classification, date, hour, the symbol of the list learned, the experimental group to which the subject was allocated, and a scale for recording the subject's judgment as to the intensity of the punishment experienced.

The intensity scale presented to the subject was a separate typewritten sheet with a vertical rectangle suggesting a foot rule. Nine equal steps were marked off on this rectangle and labeled as follows: (0) no sensation; (1) barely feel the current; (2) slight tingling; (3) tingling; (4) strong tingling; (5) slight pain; (6) painful; (7) very painful; (8) extremely painful. The subject expressed his judgment in terms of the numerals.

149 subjects took part in the experiment. 34 served in preliminary experiments in perfecting the technique and apparatus, while the records from 25 subjects who participated in the main experiment could not be used. The reasons for discarding these latter records may be summarized as follows: 11 misinterpreted the general problem on the first day and failed to learn it until the second or third day; 5 were lost due to apparatus difficulties; 3 failed to return on the second or third day.

The data presented are based upon records taken on 90 male subjects, each of whom learned three combinations, one per day at the same hour on three successive days (slight variations in time of work occurred with a few subjects, but these are equally distributed between the experimental groups). These subjects varied in age from 17 to 35 with the average age probably around 24 years. They varied in scholastic standing from sophomore to 3rd year graduate students.

These 90 subjects were distributed equally between the three experimental groups: (1) Control, or no punishment; (2) Ankle group, or punishment on the ankle; and (3) Finger group, or punishment on the finger. The three groups were equated as to age and scholastic standing. Seasonal and daily variations that might have influenced the intensity of the punishment, and variations in the efficacy of the instruction that might have crept in during the year that these data were being collected were effectually counterbalanced by following the plan of distributing each set of subjects equally between the three experimental groups.

## CHAPTER III. DATA AND DISCUSSION

The present experiment, as stated in the Introduction, was organized to investigate two questions: first, to determine the effect of punishment upon efficiency of learning in a ten-unit finger-response multiple-choice serial-order learning problem; second, to determine whether punishment applied to the ankle would result in more or less efficient learning in this type of problem than when the punishment is applied to the reacting finger.

The data collected permit two general approaches to the study of the questions investigated: first, in terms of the general criteria of total trials, total time and total errors; second, in terms of the special features of this type of problem.

The first approach permits the investigation of the two principal questions with reference to the following subsidiary problems:

1. The variable effect of punishment upon the respective criteria of learning (*i.e.* whether it has the most effect upon trials, time or errors);
2. The effect of punishment upon adaptation to a novel problem;
3. The day to day adaptation to a problem involving punishment;
4. The relation of the intensity of punishment to the criteria of learning.

The second approach involves an analysis of the situation faced in learning each combination. Such an analysis indicates that each subject had two distinct adaptations to make: first, exploration and memorization; that is, in the first trial he had to continue to tap the keys until he had found each unit of the combination and had attempted to memorize it in its proper order; second, retention and correction; that is, in the later trials he had to attempt to retain the correct combination in the proper order, or, failing in this, he had to correct any 'errors in order'<sup>3</sup> with as few trials and as little exploration as possible. Obviously, punishment might be a

<sup>3</sup> The phrase 'errors in order' is used here to distinguish errors in memorization from the errors made in the exploratory search for a correct key.



differentiating factor in these two parts of the problem. This analysis then suggests the further study of the two main questions in relation to:

5. The effect of punishment during the exploratory trials; and

6. The effect of the punishment during the later trials.

The statistical treatment of the data in the present experiment has involved: (a) The calculation of the means and the evaluation of the differences between the means in terms of the probable error of the difference. The probable errors of the mean were calculated by the use of the formula,  $P.E. = .6745 \sigma / \sqrt{n}$ . (b) The calculation of the standard deviations and the evaluation of the differences in spread in terms of the probable error of the difference between the standard deviations. (c) Day to day consistency and trend have also been used in evaluating the data, since most of the differences obtained do not meet the present accepted statistical criterion of being three times their own probable errors.

Contrary to the practice usually followed in dealing with learning data, the time for each correct trial and the two correct trials have been included in their respective totals. This is justifiable since the time in the correct trial might possibly vary with the experimental condition or group.

TABLE IA

AVERAGE TIME, AVERAGE TRIALS AND AVERAGE ERRORS WITH STANDARD DEVIATIONS FOR EACH EXPERIMENTAL GROUP ON EACH DAY

|                    | Day I |       | Day II |       | Day III |       |
|--------------------|-------|-------|--------|-------|---------|-------|
|                    | Mean  | S.D.  | Mean   | S.D.  | Mean    | S.D.  |
| Time, in seconds   |       |       |        |       |         |       |
| Ankle group.....   | 546.0 | 291.1 | 313.0  | 211.5 | 285.7   | 136.9 |
| Finger group.....  | 522.4 | 358.5 | 300.4  | 121.3 | 263.2   | 124.7 |
| Control group..... | 546.9 | 347.6 | 272.2  | 125.2 | 302.0   | 175.5 |
| Trials             |       |       |        |       |         |       |
| Ankle group.....   | 7.04  | 4.30  | 6.70   | 3.65  | 6.53    | 3.09  |
| Finger group.....  | 8.60  | 4.98  | 7.30   | 3.22  | 6.83    | 3.16  |
| Control group..... | 9.96  | 5.13  | 7.93   | 4.34  | 7.96    | 4.45  |
| Errors             |       |       |        |       |         |       |
| Ankle group.....   | 101.8 | 63.4  | 50.6   | 31.9  | 46.2    | 27.4  |
| Finger group.....  | 127.7 | 122.5 | 55.8   | 34.8  | 46.2    | 29.4  |
| Control group..... | 129.8 | 81.9  | 74.6   | 71.8  | 69.9    | 46.4  |

TABLE IB

THE COEFFICIENTS OF THE RELIABILITY OF THE DIFFERENCES BETWEEN THE MEANS  
GIVEN IN TABLE IA

|                     | Day I | Day II | Day III |
|---------------------|-------|--------|---------|
| Time                |       |        |         |
| Ankle-Finger.....   | .41   | .44    | .99     |
| Control-Finger..... | .39   | -1.30  | 2.22    |
| Control-Ankle.....  | .016  | -1.39  | .59     |
| Trials              |       |        |         |
| Finger-Ankle.....   | 1.80  | 1.00   | .56     |
| Control-Finger..... | 1.54  | .94    | 1.67    |
| Control-Ankle.....  | 3.53  | 1.70   | 2.16    |
| Errors              |       |        |         |
| Finger-Ankle.....   | 1.86  | .90    | .00     |
| Control-Finger..... | .12   | 1.91   | 3.51    |
| Control-Ankle.....  | 2.20  | 2.48   | 3.57    |

TABLE IC

THE COEFFICIENTS OF THE RELIABILITY OF THE DIFFERENCES BETWEEN THE STANDARD  
DEVIATIONS GIVEN IN TABLE IA

|                     | Day I | Day II | Day III |
|---------------------|-------|--------|---------|
| Time                |       |        |         |
| Ankle-Finger.....   | -1.68 | 4.20   | .76     |
| Control-Finger..... | -0.25 | .25    | 2.74    |
| Control-Ankle.....  | 1.43  | -4.03  | 2.00    |
| Trials              |       |        |         |
| Finger-Ankle.....   | 1.21  | -1.02  | .18     |
| Control-Finger..... | .24   | 2.38   | 2.74    |
| Control-Ankle.....  | 1.43  | 1.40   | 2.95    |
| Errors              |       |        |         |
| Finger-Ankle.....   | 4.90  | .70    | .55     |
| Control-Finger..... | -3.15 | 5.32   | 3.50    |
| Control-Ankle.....  | 2.04  | 5.80   | 4.04    |

*Section I.*—The variable effect of punishment upon the respective criteria of learning:

Three relatively independent criteria of learning efficiency were used in this experiment. It is possible that punishment for errors might produce any one of the following results: (a) all criteria might be equally affected; (b) two of the criteria might be more definitely affected than the third; (c) one of the criteria might be markedly affected while the others were only slightly disturbed. An examination of Tables IA, IB and IC above will show that this latter possibility is the truer statement of the present results. Error averages were more

definitely and consistently affected by the punishment than were the time averages or the trial averages.

This is in agreement with the findings of Rexroad, Bunch, and Vaughn in so far as it applies to the reduction of errors with punishment. Bunch, using maze learning, also found a marked reduction in time and trials.

*Section 2.*—The effect of punishment upon adaptation to a novel problem:

All subjects in all three groups read the same instructions. If the fear of the electric shock as suggested by the instructions rather than the shock itself were the dominant factor in the adjustment, the three groups should have been approximately equal in all criteria on the first day. But, a careful examination of the results obtained on the first day (Tables *IA*, *IB*, *IC*) will show that there are differences between the three groups. In average time there are no marked differences, but in average trials and average errors there are distinct differences. The punished groups require fewer trials to learn, and somewhat fewer errors.

A comparison of the means of the finger and the ankle groups shows that the ankle group required fewer trials to learn and made fewer errors than did the finger group. The experimenter's observation of the behavior adjustments made by the members of the two groups during the learning period on the first day indicates that the obtained differences are due to differences in the experimental situation rather than to a chance superiority of one group. It was noted very early in the course of the experiment that the members of the finger group very quickly adapted to the situation by tapping the keys quite hard and by withdrawing the hand very quickly; while the members of the ankle group, on the other hand, tended to press the keys and to hold them down a fraction of a second longer than did the members of the finger group. The effect of this difference in behavior adjustment was that certain of the finger-punished individuals tended to lose track of the key they had just touched, while the ankle-punished individuals, on the contrary, took time to observe the key touched in reference to the other keys but experienced a longer and more intense punishment.



Since the total time is approximately the same with all three groups and yet the punished groups made fewer errors, it is possible that the effect of the punishment was to produce more cautious behavior. An index of speed, or caution, is made possible by the nature of the experiment since a key has to be touched before either an advancement or an error may occur. The average number of seconds per response or per key touched may be obtained by the use of the formula:

$$\frac{\text{Total Time}}{\text{Total Errors} + 10 (\text{Total Trials})}$$

By the use of this formula the first day averages for each of the three groups were found to be: Ankle 3.26 ( $\pm .17$ ) seconds per response; Finger 3.03 ( $\pm .15$ ) seconds per response; and, Control 2.61 ( $\pm .19$ ) seconds per response. The differences between the punished groups and the control group are about two times their probable errors.

In so far as punishment results in more cautious behavior, these findings verify the earlier experiments of Johanson, Rexroad, Bunch, Vaughn, and Vaughn and Diserens. Whether cautious behavior, however, produces beneficial or detrimental results probably depends upon the nature of the problem and the criteria used.

*Section 3.*—The day to day adaptation to a problem involving punishment:

Logically, there are three possibilities as to the part the punishment might play throughout the three days: (a) the groups might maintain their same relative position as on the first day; (b) they might become further separated; or (c) the punishment factor might be adapted to and the behavior become more similar. All three effects were obtained, but with different criteria and different groups.

Referring to the tables again, it may be observed that so far as time averages are concerned there are no consistent relations between the punished groups and the control group. However, a comparison of the means of the ankle and the finger groups shows a slight but consistent difference in favor of the finger group. Each group shows a marked reduction

in average time on the second and third day as compared with its own first day average.

The punished groups consistently learn in fewer trials and with less variability than the control group on all three days. It may also be noted that the finger group improves more rapidly, relatively speaking, than the ankle group. On the third day both punished groups learn the combination in approximately the same number of trials.

The punished groups show a marked day to day improvement over the control group in errors. The differences obtained on the third day are three times their probable errors. It may also be noted that the punished groups show consistently less variability in errors on the second and third days; here again the differences obtained are three, four and five times their probable errors. A more detailed description of the adjustments that resulted in these differences will be given in Sections 5 and 6.

The finger punished group, as noted in Section 2, made almost as many errors as did the control group on the first day. On the second day they made only slightly more errors on the average than did the ankle group. Both the finger and the ankle groups made the same average number of errors on the third day. Here, as in trials, punishment tends to produce greater uniformity of behavior.

*Section 4.*—The relation of the intensity of punishment to the criteria of learning:

Bunch, using a ten-point scale varying between the extremes of (1) 'least perceptible shock', and (10) 'most one could stand', found the most efficient learning with those subjects that reported an intensity of (4) and (5). His objective current was kept constant. In view of this report, scatter-diagrams were plotted with the data obtained in this experiment. There was so little evidence of relation in these diagrams that no attempt was made to calculate correlation coefficients. However, the present results are not to be considered as contradictory to the results obtained by Bunch, or by Vaughn and Diserens, since the scale used in estimating the punishment, the objective intensities used, the manner of

application, and the problem to be solved differed in each experiment.

TABLE II

AVERAGE TIME PER RESPONSE IN RELATION TO AVERAGE SUBJECTIVE INTENSITY

|                    | Day I | Day II | Day III |
|--------------------|-------|--------|---------|
| Time per response  |       |        |         |
| Ankle group.....   | 3.26  | 2.72   | 2.74    |
| Finger group.....  | 3.04  | 2.48   | 2.50    |
| Control group..... | 2.61  | 2.23   | 2.22    |
| Intensity reported |       |        |         |
| Ankle group.....   | 4.08  | 4.01   | 3.76    |
| Finger group.....  | 3.80  | 3.48   | 3.33    |
| Control group..... | 0     | 0      | 0       |

Though there seems to be little correlation within either group between intensity of punishment and learning efficiency, it is interesting to note that the day to day differences between the finger and ankle groups in 'number of seconds per response' (see Section 2) are correlated with differences in the reported intensity of experience as shown in Table II above.

A careful study of this table suggests that the differences between the finger and the ankle groups which were discussed in Sections 2 and 3 might be primarily due to differences in intensity of punishment. To investigate this possibility a study was made in which reported intensity was held constant by selecting the records of those individuals in each group that could be paired with a member of the other group that reported a punishment experience of the same intensity. The results obtained are given in Table III.

TABLE III

AVERAGE SCORES WHEN REPORTED INTENSITY OF PUNISHMENT IS HELD CONSTANT

|                        | Day I | Day II | Day III |
|------------------------|-------|--------|---------|
| Number in groups.....  | 24    | 21     | 21      |
| Average intensity..... | 4.04  | 3.5    | 3.7     |
| Average time: A.....   | 539.9 | 286.8  | 266.3   |
| F.....                 | 533.6 | 280.5  | 228.0   |
| Average trials: A..... | 7.29  | 6.5    | 5.76    |
| F.....                 | 8.5   | 7.0    | 5.76    |
| Average errors: A..... | 91.6  | 49.6   | 41.3    |
| F.....                 | 108.7 | 52.0   | 38.1    |

In the above table it is interesting to note that the differences discussed in the preceding sections still remain after

punishment is equated, though they are greatly reduced in magnitude and statistical significance. This would suggest the conclusion that the finger-ankle spatial factor is relatively unimportant in this type of problem beyond the first day.

That in Table II the averages of the reported intensity should vary after the preliminary experiments in which objective values were selected that were experienced as subjectively equal, is probably due to two peculiarities of this experimental set-up: (a) As previously mentioned in Section 2 the ankle-punished individuals tended to hold down the keys longer than did the finger-punished individuals. (b) In addition, the subjective experience of the finger-punishment was not quite the same as that of the ankle-punishment. The experience of the finger-punishment may be described as a painful tingle and muscle-jerk which spread through the finger and back of the hand and persisted only while the current was passing. The ankle-punishment may better be described as an half-inch area of hot sharp needle-like pains which persisted for a brief time after the current ceased. Both groups experienced the electric shock as punishment and both considered it very unpleasant, but the persistence of the pain of the ankle-punishment tended to influence the subjects of that group to report it as being the more intense.

*Section 5.*—The effect of punishment during the exploratory trial:

The first trial in learning any of the combinations, as pointed out in the preliminary discussion of the results, differs markedly from the later trials in the nature of the adaptation which is required of the subject. Exploration is required, which may be cautious and logical or rapid and random, and memorization. If the exploration is cautious and logical, the subject will get through the combination with a minimum of errors, though probably with an increase in time. If the memorization is thorough, it is probable that the subject will make the two errorless runs very quickly after the initial trial. Thorough memorization, however, would also probably require additional time in the first trial.

In Tables IV *A* and IV *B* it is clearly evident that the



TABLE IVA

TIME AND ERROR AVERAGES MADE IN THE INITIAL TRIAL IN  
LEARNING EACH COMBINATION

|                    | Day I                 | Day II               | Day III              |
|--------------------|-----------------------|----------------------|----------------------|
| Time in seconds    |                       |                      |                      |
| Ankle group.....   | 184.4 ( $\pm 11.70$ ) | 116.0 ( $\pm 5.08$ ) | 119.9 ( $\pm 6.29$ ) |
| Finger group.....  | 178.5 ( $\pm 10.37$ ) | 109.2 ( $\pm 4.94$ ) | 104.0 ( $\pm 4.45$ ) |
| Control group..... | 150.4 ( $\pm 13.60$ ) | 101.8 ( $\pm 7.59$ ) | 92.4 ( $\pm 6.91$ )  |
| Errors             |                       |                      |                      |
| Ankle group.....   | 45.7 ( $\pm 2.53$ )   | 28.3 ( $\pm 1.12$ )  | 28.1 ( $\pm 1.14$ )  |
| Finger group.....  | 43.8 ( $\pm 2.25$ )   | 29.5 ( $\pm 1.35$ )  | 29.3 ( $\pm 1.34$ )  |
| Control group..... | 50.8 ( $\pm 3.09$ )   | 36.0 ( $\pm 3.07$ )  | 31.9 ( $\pm 1.44$ )  |

TABLE IVB

THE COEFFICIENTS OF THE RELIABILITY OF THE DIFFERENCE BETWEEN THE MEANS  
GIVEN IN TABLE IVA

|                     | Day I | Day II | Day III |
|---------------------|-------|--------|---------|
| Time                |       |        |         |
| Ankle-Finger.....   | .30   | .96    | 2.06    |
| Finger-Control..... | 1.64  | .80    | 1.40    |
| Ankle-Control.....  | 1.89  | 1.54   | 2.93    |
| Errors              |       |        |         |
| Finger-Ankle.....   | -.58  | .70    | .72     |
| Control-Finger..... | 1.85  | 1.62   | 1.29    |
| Control-Ankle.....  | 1.27  | 2.34   | 2.07    |

punished groups required more time, but made fewer errors than the control group in the initial trial on each day. This would indicate that the addition of punishment to the experimental situation resulted in a more cautious approach on the part of the punished individuals.

A comparison of the finger and ankle groups in the same tables shows that the finger group took less time but made more errors on two of the three days, though the differences are rather small. This again would indicate that whatever the difference between punishment on the finger and the ankle may be, it is something which results in a slightly more cautious approach on the part of the ankle-punished individuals.

In Section 2 it was suggested that the average number of seconds per response was a fair index of the caution exerted by the subject. Using the formula presented in that section,

the average number of seconds per response was calculated for both the first trial and the later trials for each group each day and the results are presented in Table VA. In Table VB are given the coefficients of the reliability of the difference between the means.

TABLE VA

THE AVERAGE NUMBER OF SECONDS PER RESPONSE FOR (a) FIRST TRIAL, (b) LATER TRIALS, FOR EACH GROUP ON EACH DAY

|                    | Day I                | Day II               | Day III              |
|--------------------|----------------------|----------------------|----------------------|
| (a) First trial    |                      |                      |                      |
| Ankle group.....   | 3.663 ( $\pm .177$ ) | 3.179 ( $\pm .157$ ) | 3.302 ( $\pm .193$ ) |
| Finger group.....  | 3.574 ( $\pm .203$ ) | 2.943 ( $\pm .159$ ) | 2.812 ( $\pm .137$ ) |
| Control group..... | 2.652 ( $\pm .248$ ) | 2.665 ( $\pm .253$ ) | 2.362 ( $\pm .171$ ) |
| (b) Later trials   |                      |                      |                      |
| Ankle group.....   | 2.927 ( $\pm .221$ ) | 2.267 ( $\pm .129$ ) | 2.140 ( $\pm .111$ ) |
| Finger group.....  | 2.753 ( $\pm .145$ ) | 2.098 ( $\pm .076$ ) | 2.121 ( $\pm .083$ ) |
| Control group..... | 2.610 ( $\pm .199$ ) | 1.850 ( $\pm .117$ ) | 2.096 ( $\pm .128$ ) |

TABLE VB

THE COEFFICIENTS OF THE RELIABILITY OF THE DIFFERENCES BETWEEN THE MEANS GIVEN IN TABLE VA

|                     | Day I | Day II | Day III |
|---------------------|-------|--------|---------|
| (a) First trial     |       |        |         |
| Ankle-Finger.....   | .33   | 1.05   | 2.07    |
| Finger-Control..... | 2.88  | .93    | 2.05    |
| Ankle-Control.....  | 3.32  | 1.73   | 3.65    |
| (b) Later trials    |       |        |         |
| Ankle-Finger.....   | .65   | 1.13   | .12     |
| Finger-Control..... | .58   | 1.78   | .18     |
| Ankle-Control.....  | 1.06  | 2.39   | .26     |

In Table VA, part (a), it is clearly evident that the punished groups are slower than the control group in rate of response during the first trial. In Table VB, part (a), the differences between the means of the punished and the control groups are seen to be two and three times their probable errors on two of the three days. The smaller differences obtained on the second day may be the result of a chance factor, in that three members of the control group varied markedly from the mode of their group in such a way as to greatly increase the average of that group. In so far as the number of seconds per response is an index of caution, these results

further justify the tentative conclusion that punishment results in a more cautious approach to the problem during the first trial.

The consistent daily increase of the significance of the separation between the means of the finger and the ankle groups in part (a) of Table VB is interesting. It probably indicates that the rapid tapping of the finger-punishment individuals on the second and third day resulted in the avoidance of most of the unpleasant consequences of the electric shock and therefore permitted a faster rate of response. The equally significant separation between the finger and control groups probably indicates that, though the sensory consequences were not so unpleasant, the finger group still took time to memorize the combination during the first trial.

*Section 6.*—The effect of the punishment during the later trials:

The adaptation necessary after the completion of the first trial is, first, to retain the correct combination in the proper order, and, second, to correct any 'errors in order' (see footnote number 3) that may occur with as few trial and as little exploration as possible. As previously suggested, careful memorization in the first trial would decrease the number of later trials necessary to reach the criterion. In addition to this, a cautious attitude in the exploration following an unexpected 'error in order' would probably reduce the number of errors made in the later trials.

TABLE VI.A

TIME AND ERROR AVERAGES IN THE TRIALS, AFTER THE FIRST, FOR EACH GROUP ON EACH DAY

|                    | Day I                | Day II              | Day III             |
|--------------------|----------------------|---------------------|---------------------|
| Time in seconds    |                      |                     |                     |
| Ankle group.....   | 362.4                | 197.0               | 165.7               |
| Finger group.....  | 377.2                | 223.9               | 163.3               |
| Control group..... | 399.8                | 174.0               | 210.5               |
| Errors             |                      |                     |                     |
| Ankle group.....   | 55.7 ( $\pm 6.68$ )  | 22.5 ( $\pm 3.36$ ) | 18.5 ( $\pm 3.03$ ) |
| Finger group.....  | 79.8 ( $\pm 13.97$ ) | 26.6 ( $\pm 3.91$ ) | 17.1 ( $\pm 2.87$ ) |
| Control group..... | 77.6 ( $\pm 9.56$ )  | 38.0 ( $\pm 7.03$ ) | 38.0 ( $\pm 5.04$ ) |

TABLE VIB

COEFFICIENTS OF THE RELIABILITY OF THE DIFFERENCES BETWEEN THE MEANS OF THE  
ERROR PART OF TABLE VIA

|                     | Day I | Day II | Day III |
|---------------------|-------|--------|---------|
| Errors              |       |        |         |
| Ankle-Finger.....   | 1.56  | -.79   | .32     |
| Control-Finger..... | -.13  | 1.41   | 3.61    |
| Control-Ankle.....  | 1.88  | 1.98   | 3.31    |

Since the means of the time part of Table VIA show no consistent relation, no attempt is here made to evaluate the statistical significance of the separations between the means.

In the error part of Table VIA it is plainly evident that the punished groups made fewer errors in the later trials on the second and third day than did the control group. In Table VIB the reliability of the separation is seen to increase from day to day until the differences are more than three times their probable errors on the third day. This justifies the conclusion that punishment results in a reduction of errors, both by causing more careful memorizing in the first trial and by assuring a cautious attitude in the correction of 'errors in order' in the later trials.

In an earlier section the marked difference in errors between the finger-punished and ankle-punished groups on the first day was accounted for in terms of the differences in the behavior adaptations made by the two groups. A comparison of the first day averages in Tables IVA and VIA shows clearly that the difference in total errors is primarily due to the number of errors piled up by the finger-punished individuals in the *later* trials. Nine of the finger group made more than one hundred errors in the later trials, while only four of the ankle-punished group exceeded this number. This increase in errors in the later trials would suggest the hypothesis that the finger punishment exerted a disruptive effect only when it came unexpectedly in the course of the later trials while learning the first combination.

A comparison of the average time per response in parts (a) and (b) of Table VA shows that the rate of response



is much slower in the first trial than in the later trials with each group on each day. In Table VII are given the coefficients of the reliability of the differences between the means of the first trial and of the later trials.

TABLE VII

THE COEFFICIENTS OF THE RELIABILITY OF THE DIFFERENCES BETWEEN THE MEAN RATE OF RESPONSE OF THE FIRST TRIAL AND THE MEAN OF THE LATER TRIALS

|                      | Day I | Day II | Day III |
|----------------------|-------|--------|---------|
| Ankle-Ankle.....     | 2.69  | 4.80   | 5.23    |
| Finger-Finger.....   | 3.29  | 4.49   | 4.31    |
| Control-Control..... | 0.13  | 2.93   | 1.24    |

The fact that the coefficients of reliability of the punished groups are markedly greater than those of the control group indicates that the punishment has by far the greater effect in the initial trial. This interpretation is further justified by comparing the coefficients of the reliability of the differences in parts (a) and (b) of Table VB. Here again it is evident that there is much greater and more significant separation between the punished and the control groups in the first trial than in the later trials. This, then, justifies the conclusion that punishment as a factor producing cautious adjustment is far more effective during the exploration and memorization of the initial trial than during the later trials.

### SUMMARY OF RESULTS

*Section 1.*—The variable effect of punishment upon the respective criteria of learning:

Errors averages were more definitely and consistently affected by the punishment than were the time or the trial averages.

*Section 2.*—The effect of punishment upon adaptation to a novel problem:

#### A. Punished vs. Control:

(1) The punished groups learn the combination on the first day with fewer trials and fewer errors, but require approximately the same total time to complete the learning.

(2) The number of seconds *per response*, or per key touched, as determined by the formula,

$$\frac{\text{Total Time}}{\text{Total Errors} + 10 (\text{Total Trials})},$$

is used as an index of the degree of caution shown by the punished groups. The first day differences between the averages of the punished and the control groups with this criterion are about two times their probable errors.

*B. Ankle vs. Finger:*

(3) The ankle-punished group learned the problem on the first day with fewer errors than did the finger-punished group. This is interpreted as being more than a chance difference since, (*a*) there is a marked difference in the behavior adjustment of the two groups; (*b*) nine of the finger group made more than one hundred errors in the 'trials after the first', while only four of the ankle group exceeded this number.

*Section 3.*—The day to day adaptation to a problem involving punishment:

*A. Punished vs. Control:*

(1) There is no consistent relation between the punished groups and the control group in average time from day to day.

(2) The punished groups consistently learned with fewer trials and fewer errors. The relative size of the standard deviations indicates that there is less individual variability in the number of trials and errors with the punished groups.

*B. Ankle vs. Finger:*

(3) The finger-punished group consistently learned in less time than the ankle-punished group, but required more trials and made more errors on days I and II.

*Section 4.*—The relation of the intensity of the punishment to the criteria of learning:

*Ankle vs. Finger:*

(1) Practically no relation was found between the reported intensity of the punishment and the respective criteria within either of the punished groups. This is not to be considered as contrary to the findings of earlier experimenters,

since the problem, the scale of estimating, and the objective intensity of the punishment used have varied in each instance.

(2) There is, however, a day to day relation between the 'average number of seconds per response' and the average 'intensity reported' when the finger group is compared with the ankle group.

(3) The differences in average time, trials and errors are greatly reduced when the two punished groups are equated in average intensity reported. This indicates that the spatial factor is relatively unimportant after the first day when intensity is 'kept constant'.

*Section 5.*—The effect of punishment during the exploratory trial:

*A. Punished vs. Control:*

(1) The punished groups required more time but made fewer errors than did the control group in the first trial on each day.

(2) Using the 'number of seconds per response' as a criterion of caution, the punished groups were found to be much more cautious in the first trial than was the control group.

*B. Ankle vs. Finger:*

(3) The finger group took less time on all three days, but made more errors than did the ankle group in the first trial on two of the three days.

(4) By the criterion used in (2) above, the ankle group is more cautious than the finger group on all three days.

*Section 6.*—The effect of punishment during the *later* trials:

*A. Punished vs. Control:*

(1) With the exception of the finger group on the first day, the punished groups consistently made fewer errors in the later trials than did the control group. The differences became more marked on the successive days. This indicates that the punished groups were more efficient in learning in the first trial on the successive days.

(2) Again using the number of seconds per response, the punished groups which were consistently and significantly

more cautious in trial one were found to be only slightly more cautious than the control group in the later trials.

### B. Ankle vs. Finger:

(3) There are no consistent differences between the ankle and the finger groups in the time and error records during the later trials.

## CONCLUSIONS

### I. Punishment Compared with No Punishment

(1) The electric shock of the intensity here used resulted in a more cautious attitude on the part of the learners in this experiment.

(2) Caution on the part of the punished learners resulted in their learning the combinations used with fewer trials and fewer errors than the non-punished learners, though they required the same amount of time.

(3) An analysis of the data of the first trial as compared with the later trials shows that the punished groups were significantly more cautious in the exploratory initial trial than in the later trials.

### II. Ankle Punishment Compared with Finger Punishment

When the intensity of the punishment is kept constant, the factor of spatial separation seems to be of minor importance in the learning of a problem of this type.

## REFERENCES

1. BROWN, W., AND WHITTELL, F., Yerkes multiple choice method with human adults. *J. Comp. Psychol.*, 1923, 3, 305-318.
2. BUNCH, M. E., The effect of electric shock as punishment for errors in human maze learning. *J. Comp. Psychol.*, 1928, 8, 343-359.
3. JOHANSON, A. M., The influence of incentive and punishment upon reaction time. *Arch. Psychol.*, 1922, 8, No. 54, pp. 53.
4. REXROAD, C. N., A continuous multiple choice reaction apparatus. *J. Exper. Psychol.*, 1925, 8, 325-336.
5. REXROAD, C. N., Administering electric shock for inaccuracy in continuous multiple-choice reactions. *J. Exper. Psychol.*, 1926, 9, 1-18.
6. VAUGHN, J., *Positive versus negative instruction*. Publications of the National Bureau of Casualty and Surety Underwriters, Educational Series, Volume II, pp. 172.
7. VAUGHN, J. AND DISERENS, C. M., The relative effects of various intensities of punishment on learning and efficiency. *J. Comp. Psychol.*, 1930, 10, 55-66.



8. WATSON, J. B., Recent experiments on how we lose and change our emotional equipment. *Ped. Sem.*, 1925, 32, 349-371.
9. WONG, HISHING, AND BROWN, W., Effects of surroundings upon mental work as measured by Yerkes' multiple choice method. *J. Comp. Psychol.*, 1923, 3, 319-330.
10. YERKES, R. M., A new method of studying the ideational behavior of mentally defective and deranged as compared with normal individuals. *J. Comp. Psychol.*, 1921, 1, 369-394.

(Manuscript received September 2, 1930)



